

# Long term effect of sediment remediation - mechanisms of failure and success based on case studies

**Arne Pettersen<sup>1</sup>, Anita Whitlock Nybakk<sup>2</sup>, Gøril Aasen Slinde<sup>1</sup>, Espen Eek<sup>1</sup>, Amy Oen<sup>1</sup>, Gijs D. Breedveld<sup>1,3</sup>**

<sup>1</sup>NGI, Sognsveien 72, Oslo, Norway<sup>1</sup>

<sup>2</sup>NGI, Høgskoleringen 9, Trondheim, Norway

<sup>3</sup> Department of Geosciences, University of Oslo, Norway

Phone: +47-90925252

E-mail: ap@ngi.no

## Introduction:

In projects that focus on the remediation of contaminated seabed, short term environmental goals are defined, and remedial measures are selected in accordance. Most used methods in Norway involve dredging and capping, but also natural restoration have been applied. Typical environmental goals include the achievement of contaminant levels in the sediment below certain threshold levels (class II in the Norwegian classification system), but also cap thickness and cap integrity might be an objective for remedial solution.

In order to achieve these environmental goals extensive investments are required.

## Methods:

In several projects NGI has been involved in the evaluation of the long term effect of remedial measures. The data and observations from these studies are used to answer the following questions:

- What are realistic long term environmental goals that can be achieved?
- Which mechanisms and factors are critical and most likely to negatively influence the remedial design and environmental goals?
- Should the observed long term achievability of environmental improvement be taken into account in the initial design of the remedial action to allow for a more realistic and efficient solution?
- To what extent are recontamination and repair acceptable in the long term life expectancy of remedial efforts?

## Results:

The achieved positive and negative effect of several sediment remediation projects will be presented. Data and observations are collected from the following projects:

The Sandefjord fjord: erosion along the docks caused by the ferry traffic required change in the design of the cap layer.

Kollevågen, Bergen: underwater waste disposal facility. Geotechnical instability influenced capping efficiency.

Oslo harbor: dredging and capping of the inner harbor area. Recolonization of benthic organisms on the new mineral capping layer.

Oslo harbor: the observed long term recontamination caused by urban runoff and river transport to the remediated area. Based on time series of monitoring data since the project was finished in 2009.



**Fig. 1:** Long term effect of the remediation of Oslo harbor, documented by field observations.

**Discussion:** The evaluation of the long term effects of sediment remediation projects show that in many cases the remedy can be regarded as successful despite the fact that not all objectives have been achieved. Recontamination and minor damages to cap layers are found, but overall this does not affect the total obtained environmental improvement.

However, it is useful to discuss if the effort invested in obtaining the initial stringent remedial goals could have been done more efficient with a stronger focus on the long term achievability of environmental improvement given the local setting and on-going processes.